MICROCONTROLLERS IN AMATEUR RADIO

BY ANTHONY A. LUSCRE*, K8ZT

Ham Radio on a Chip

Microcontroller Devices (µCD) in the Ham Shack

Microcontroller (µC), system-on-chip (SoC), or microcomputer are terms used to describe electronic devices that contain not only a processing unit but a small amount of memory (ROM and/or RAM), a few I/O (input/output) ports for peripherals, a timer, etc. No matter what we call them, they have certainly had a major impact on modern electronics and amateur radio.

Although they are more complex, their role in amateur radio follows an historical arc of game-changing circuits and components. Examples include: Vacuum tubes, early oscillator circuits that revolutionized the generation of radio waves[1]; the transistor, which

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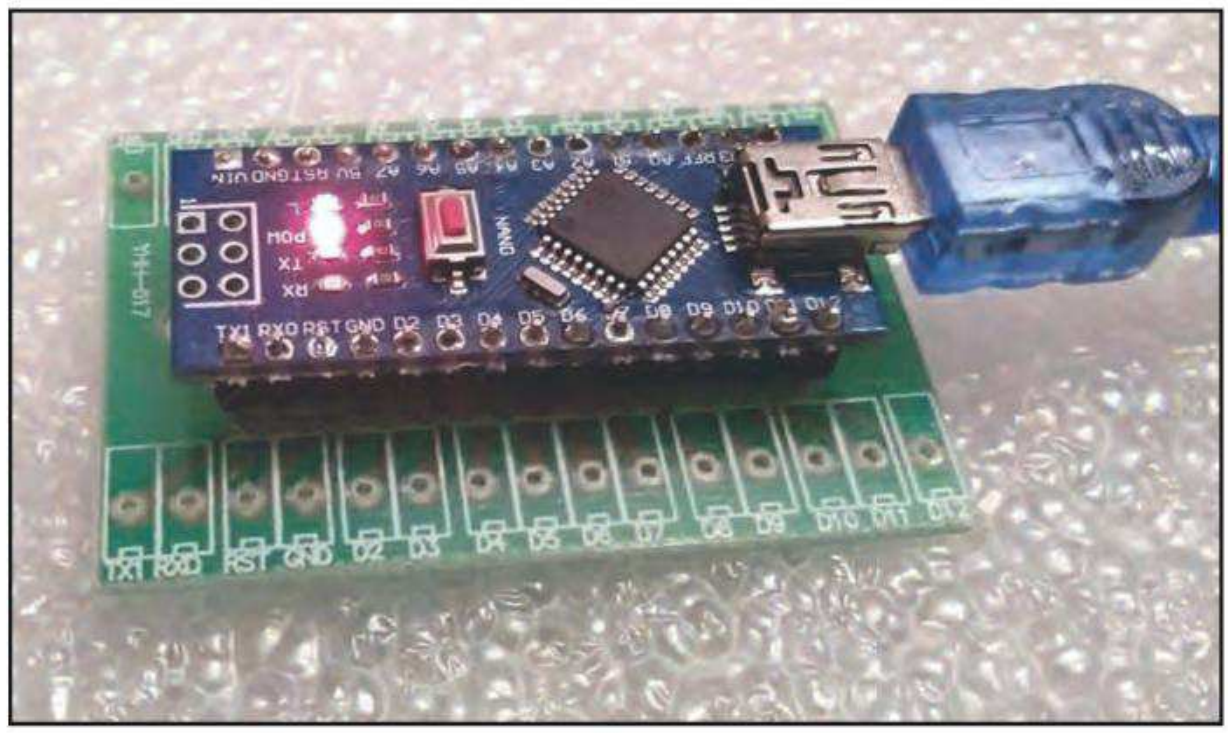

Photo A. The Arduino Nano is a popular, inexpensive, and compact example of a microcontroller device (µCD). (Photo by K8ZT)

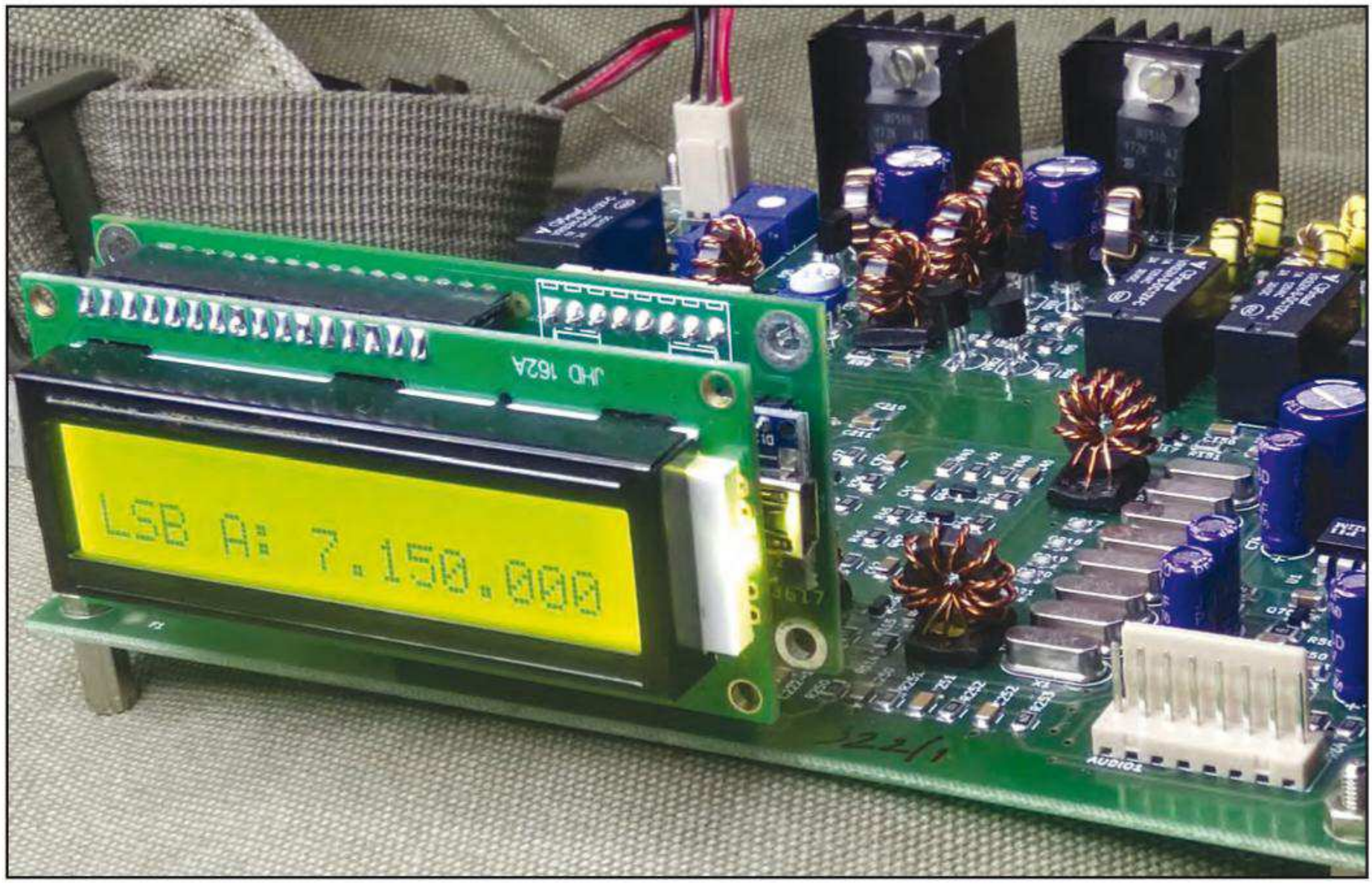

Photo B. The µBITX is a complete SSB/CW transceiver kit, controlled by an Arduino, at only $129 that has been described in previous CQ magazine articles. (Photo from <www.hfsignals.com>)

sparked the solid-state revolution; the 555 timer, a 1970s IC that spawned hundreds of useful circuits to deal with a variety of needs, etc. Today's builders and experimenters have a new tool in designing and building circuits with building blocks containing simple microcontrollers, including the Arduino (and all of its variants) (*Photo A*), Basic Stamp, PICAxe, AVR, BeagleBone, Raspberry Pi, and many others.

The purpose of this quarterly *CQ* magazine column will be to provide information, ideas, tips, projects, and news on the use of microcontroller devices (µCDs) in amateur radio. We will explore how these devices work, practical uses, programming, designing, and building of projects. For those less interested in building your own circuits, I will provide news on commercial, ready to use products and kits that incorporate µCDs.

Before we dig into specifics, you might be asking what µCDs are currently being used for in radio. Examples include replacement of traditional blocks in circuits, including VFOs, filters, frequency counters/displays and digital signal processing (DSP). They are used in a wide variety of station accessories — CW and voice keyers, multimode interfaces, antenna switches, antenna analyzers, external data displays[2], and rotor controls. µCDs are even used in complete radios as SDRs (Software Defined Radios) and/or SDR controllers, as in the BITX[3] (*Photo B*) and QRP Labs QCX[4] (*Photo C*) transceivers.

In the column, I will often refer you to my website, <www.k8zt.com>, which includes a wide variety of amateur radio resources including pages on µCDs. There you will find a number of websites to aid your journey through the use of these devices in amateur radio.

The Arduino Family

To kick off the "Microcontrollers in Amateur Radio" column, I would like to

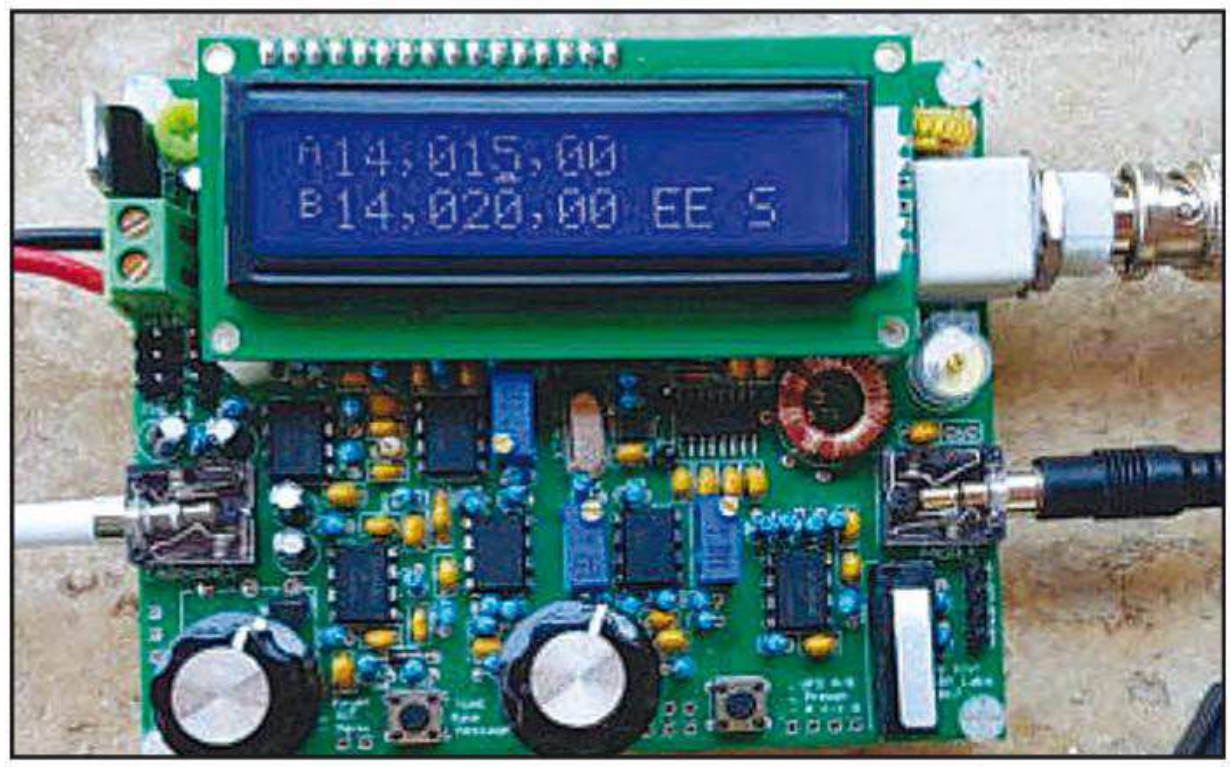

Photo C. QRP Labs' QCX transceiver is a high-performance monoband CW kit. In addition to being an integral part of the radio, the use of a µCD allows inclusion of many additional features including CW decoder (displayed real-time on-screen), built-in keyer and memories, WSPR beacon, and even built-in test equipment (VOM, RF power meter, frequency counter, and signal generator). (Photo from <www.qrp-labs.com>)

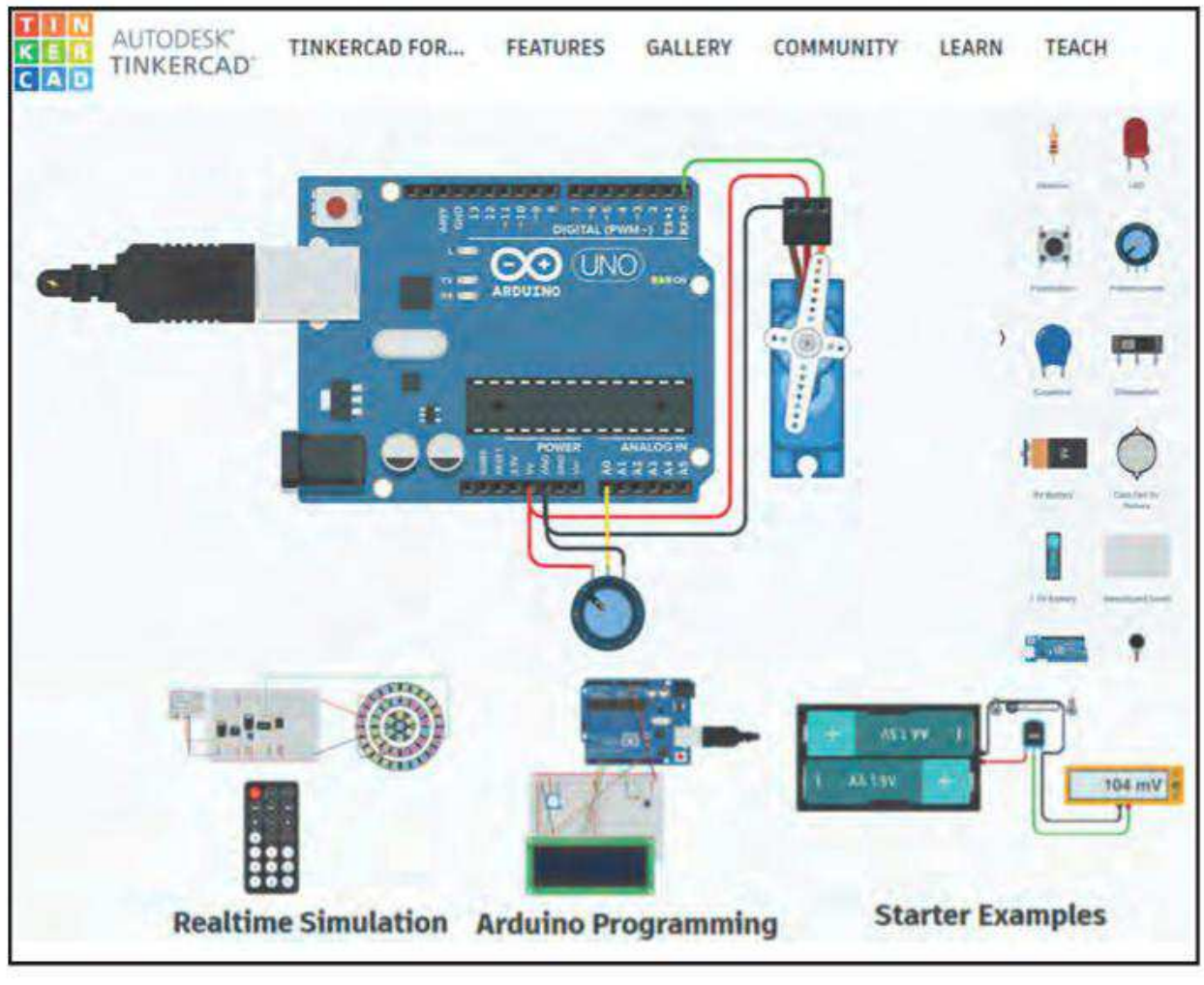

Photo D. Autodesk© TinkerCAD free online Arduino simulator. (Screen capture from <www.tinkercad.com/circuits>)

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focus on one of the many µCDs — the Arduino family. I say family because there is actually quite a wide variety of Arduino variants available. This is because the Arduino is an open-source hardware project based on the ATmega328P, so vendors can design and build their own variants. In addition to the open-source hardware, Arduinos have an open-source software Integrated Development Environment (IDE) that runs on your PC. The IDE is used to write programs and to upload resulting computer code to the physical board via USB interface.

The good news is that it is both inexpensive and easy to get started working with Arduino. With Nano variants selling for under $5 each, dirt-cheap add-on modules, a few standard parts that you might already have lying around (resistors, LEDs, etc.) and free development software, you can get started for the cost of a lunch for two. The first thing you will probably want to do is download and install the free IDE software. Your two main software options are from the Arduino community site — either the standalone software you can download and install on your Windows, Mac, or Linux computer or the Arduino Create online app version that runs in your browser. Both of these are available at <https://tinyurl.com/3qhpzn>. If you choose the Arduino Create Online App route, you will need to sign up for an account to access the software and store your sketches (projects).

Your next step would be to learn more about Arduino and Arduino projects by visiting any of the many web resources on my website or settling in with a good book. There are numerous general Arduino books and even amateur radio specific offerings including two popular ARRL-published books by Glen Popiel, KW5GP. If you would like to try some Arduino projects without any hardware there are a wide variety of online circuit simulators and Arduino emulators. One free example is <www.tinkercad.com/circuits> (*Photo D*).

See What You Can Do

Once you have gotten some background, or if you are a "just let me give it a try" learner, I would suggest buying an Arduino (either a Nano or Uno R3 board) and a few add-on devices (known as shields) to begin experimenting. There are reasonably priced starter kits offered at local hamfests and online stores/auction sites (just search "Arduino starter kit" and you'll find a bunch). If you already have a well-stocked junk box, you may only need an Arduino itself, a USB cable (A-micro) to connect the Arduino to your computer (for programming and powering the device), a breadboard and jumper wires.

Until next time, for some project ideas to get you started, visit the Arduino project site <create.arduino.cc/projecthub>, Instructables at <https://tinyurl.com/yasqbrpk>, Circuit Digest at <https://tinyurl.com/ycldvmzu>, and W5DOR's Arduino page at <https://tinyurl.com/ydxa36ns> (the latter includes ham-specific projects).

I always welcome your email comments and questions to make this column better.

Notes:

1. <https://bit.ly/1RzBxsS >
2. Luscre, A. (2018, March). *View More Decoded Characters from Elecraft KX2 or KX3 Transceiver with the KX 2nd Look* CQ Magazine, 74(3), 20-22.
3. HF Signals <www.hfsignals.com>
4. QRP LAbs <www.qrp-labs.com/qcx.html>